

WHAT IS CLAIMED IS:

1. An MPEG-4 live unicast video streaming system for use in a wireless network including an end-to-end congestion control mechanism that can
5 automatically and dynamically adjust a data-bitrate/transmission bitrate according to an available network bandwidth, the system comprising:

(1) a rate adaptive MPEG-4 simple profile encoder for generating MPEG-4 simple profile live video data through an encoding process with an adjustable encoding bitrate, for transmitting the generated MPEG-4 simple
10 profile live video data by HTTP/TCP through a LAN, and for adjusting the encoding bitrate in accordance with a bitrate control requirement;

(2) a streaming server;

(2a) a data receiver module provided in the streaming server for receiving the MPEG-4 simple profile live video data by HTTP/TCP from the
15 rate adaptive MPEG-4 simple profile encoder through the LAN;

(2b) an RTSP server module provided in the streaming server for handling a streaming session;

(2c) an RTP/RTCP transport engine server module provided in the streaming server for segmentizing the MPEG-4 simple profile live video data
20 received by the data receiver module on the basis of GOVs, for packetizing each GOV as payload of RTP packets, and for transmitting the RTP packets through a wireless network according to a bitrate of each GOV, whereas RTCP is implemented for transporting retransmission request and reply;

(2d) a bitrate adapter module provided in the streaming server for
25 implementing a bitrate adaptation protocol and a network bandwidth polling protocol to allow the streaming server to proceed with bitrate control tasks, and forwarding an incoming bitrate control decision to the rate adaptive MPEG-4 simple profile encoder as the bitrate control requirement;

(2e) a data link buffer provided in the streaming server for storing the MPEG-4 simple profile live video data received by the data receiver module as MPEG-4 GOV data;

(3) a client;

5 (3a) a rate adaptive MPEG-4 simple profile decoder provided in the client for decoding received MPEG-4 GOV data and rendering pictures represented by the received MPEG-4 GOV data;

(3b) an RTSP client module provided in the client for handling the streaming session;

10 (3c) an RTP/RTCP transport engine client module provided in the client for receiving the RTP packets from the streaming server through the wireless network, for depacketizing and desegmentizing the payload of the received RTP packets to each GOV of MPEG-4 GOV data, whereas RTCP is implemented for transporting retransmission request and reply;

15 (3d) a bitrate adapter module provided in the client for implementing the bitrate adaptation protocol and the network bandwidth polling protocol to allow the client to proceed with bitrate control tasks, and for forwarding the bitrate control decision to the streaming server; and

 (3e) a data link buffer provided in the client for storing the MPEG-4
20 GOV data generated by the RTP/RTCP transport engine client module, for collecting bitrate control information, and for forwarding the collected bitrate control information to the bitrate adapter module in the client.

2. An MPEG-4 live unicast video streaming system as recited in claim 1,
25 wherein the data link buffer in the streaming server comprises:

 means for storing the MPEG-4 simple profile live video data as a link of GOVs with related information representative of parameters including a GOV bitrate, a GOV duration, and a GOV size;

interfaces for inserting a GOV, reading out a GOV, and searching for a GOV; and

means for, when a speed of GOV reading is slower than a speed of GOV inserting, allowing overwriting an old unread GOV with

5 resynchronization of read and write pointers by resetting a buffer status and dropping rest unread GOVs.

3. An MPEG-4 live unicast video streaming system as recited in claim 1, wherein the RTP/RTCP transport engine server module comprises:

10 means for segmentizing and packetizing each GOV into RTP packets and then packing one RTP packet as payload of one UDP packet, and for pushing the UDP packet to the client through the wireless network according to a data bitrate;

means for receiving a retransmission request from the client
15 through a UDP connection which loads an RTCP packet with information representative of the retransmission request;

means for, upon receiving the retransmission request, searching the data link buffer in the streaming server for a required GOV;

means for, when the required GOV is found, retransmitting at least a
20 portion of the required GOV which contains required data to the client using RTP packets; and

means for, when the required GOV fails to be found, returning a negative acknowledgement of forbidden-retransmission to the client through an RTCP channel.

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4. An MPEG-4 live unicast video streaming system as recited in claim 1, wherein the bitrate adapter module in the streaming server comprises:

means for receiving the bitrate control information from the client as

the bitrate control decision and proceeding with bandwidth polling with cooperation of the client; and

means for forwarding the bitrate control decision to the rate adaptive MPEG-4 simple profile encoder as the bitrate control requirement.

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5. An MPEG-4 live unicast video streaming system as recited in claim 1, wherein the data link buffer in the client comprises:

means for storing the MPEG-4 simple profile live video data as a link of GOVs with related information representative of parameters including a

10 GOV bitrate, a GOV duration, and a GOV size;

interfaces for inserting a GOV, inserting a blank GOV, inserting data of an incomplete GOV, reading out a GOV, and searching for a GOV;

means for, when a speed of GOV reading is slower than a speed of GOV inserting, allowing overwriting an old unread GOV with

15 resynchronization of read and write pointers by resetting a buffer status and dropping rest unread GOVs;

means for verifying an incomplete GOV and sending a retransmission request corresponding to the verified incomplete GOV to the RTP/RTCP transport engine client module;

20 means for recovering a complete GOV corresponding to the incomplete GOV from retransmitted data; and

means for collecting a current buffer status as the bitrate control information and sending the bitrate control information to the bitrate adapter module in the client.

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6. An MPEG-4 live unicast video streaming system as recited in claim 1, wherein the RTP/RTCP transport engine client module comprises:

means for receiving the RTP packets by a UDP connection through

the wireless network, and then desegmentizing and depacketizing the received RTP packets to each GOV;

means for inserting one of an incomplete GOV and a blank GOV into the data link buffer in the client upon occurrence of one of packet loss and
5 packet out-of-sequence;

means for receiving the retransmission request from the data link buffer in the client, and then forwarding the retransmission request to the RTP/RTCP transport engine server module through a UDP connection which loads an RTCP packet with information representative of the
10 retransmission request;

means for, upon receiving the retransmitted data, searching the data link buffer in the client for a specified GOV;

means for, when the specified GOV is found, inserting the retransmitted data or a whole GOV containing the retransmitted data into
15 its position in the data link buffer in the client; and

means for setting a forbidden-retransmission flag of the specified GOV in the data link buffer in the client to forbid a further retransmission request when a forbidden-retransmission RTCP packet is received.

20 7. An MPEG-4 live unicast video streaming system as recited in claim 1, wherein the bitrate adapter module in the client comprises:

means for receiving the bitrate control information from the data link buffer in the client;

means for making the bitrate control decision in response to the
25 received bitrate control information;

means for forwarding the bitrate control decision to the bitrate adapter module in the streaming server through a TCP connection;

means for, according to the network bandwidth polling protocol,

activating a polling process to work with the bitrate adapter module in the streaming server; and

means for initiating an auto-negotiation on an initial streaming bitrate between the streaming server and the client to work with the bitrate adapter module in the streaming server by using the network bandwidth
5 polling protocol.

8. An MPEG-4 live unicast video streaming system as recited in claim 1, wherein each RTP packet has an extended structure including additional
10 fields defined for depacketization and desegmentation.

9. An MPEG-4 live unicast video streaming system as recited in claim 3, wherein the RTCP packet has a user application structure including additional fields defined for retransmission.
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10. An MPEG-4 live unicast video streaming system as recited in claim 1, wherein each of the data link buffer in the streaming server and the data link buffer in the client stores a GOV in one GOV node with related information.
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11. An MPEG-4 live unicast video streaming system as recited in claim 1, further comprising a retransmission mechanism for retransmitting data from the streaming server to the client, the retransmission mechanism including the data link buffer in the client, the RTP/RTCP transport engine client module, and the RTP/RTCP transport engine server module.
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12. An MPEG-4 live unicast video streaming system as recited in claim 1, further comprising means provided in the bitrate adapter module in the

streaming server and the bitrate adapter module in the client for implementing the network bandwidth polling protocol.

13. An MPEG-4 live unicast video streaming system as recited in claim 1,
5 further comprising means provided in the data link buffer in the client, the bitrate adapter module in the streaming server, and the bitrate adapter module in the client for implementing the bitrate adaptation protocol.

14. An MPEG-4 live unicast video streaming system as recited in claim
10 13, wherein the bitrate adaptation protocol includes a bitrate decision rule with implementation of a decision sliding window.

15. An MPEG-4 live unicast video streaming system comprising:
an MPEG-4 encoder encoding an information signal into MPEG-4
15 data composed of successive GOVs at an adjustable encoding bitrate and outputting the GOVs, and adjusting the encoding bitrate in accordance with a bitrate control signal;
a streaming server receiving the GOVs from the MPEG-4 encoder;
first means provided in the streaming server for changing each
20 received GOV into packets;
second means provided in the streaming server for wirelessly transmitting the packets generated by the first means;
a client wirelessly receiving the packets from the streaming server;
third means provided in the client for changing the received packets
25 into each recovered GOV;
a buffer memory provided in the client for temporarily storing recovered GOVs generated by the third means;
fourth means for reading out each GOV from the buffer memory;

fifth means for calculating a remaining playback time corresponding to GOVs in the buffer memory which have not yet been read out by the fourth means;

sixth means provided in the client for generating the bitrate control
5 signal in response to the remaining playback time calculated by the fifth means;

seventh means for wirelessly transmitting the bitrate control signal generated by the sixth means to the streaming server; and

eighth means for transmitting the bitrate control signal from the
10 streaming server to the MPEG-4 encoder.

16. An MPEG-4 live unicast video streaming system as recited in 15, wherein the fourth means comprises an MPEG-4 decoder decoding each GOV read out from the buffer memory into a corresponding portion of an
15 original information signal.

17. An MPEG-4 live unicast video streaming system as recited in 15, further comprising:

ninth means for deciding whether or not each GOV in the buffer
20 memory is short of data and requires absent data;

tenth means for, when the ninth means decides that a GOV in the buffer memory is short of data and requires absent data, generating a retransmission packet loaded with the absent data in the streaming server;

eleventh means for wirelessly transmitting the retransmission
25 packet from the streaming server to the client;

twelfth means provided in the client for extracting the absent data from the retransmission packet; and

thirteenth means provided in the client for inserting the absent data

extracted by the twelfth means into the data-short GOV in the buffer memory.